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MEMOIR

JOSEPH LEIDY, M. D., LL. D.

BY

HENRY C. CHAPMAN, M. D.,

PROFESSOR OF INSTITUTES OF MEDICINE IN THE JEFFERSON MEDICAL COLLEGE.

FROM THE PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA, JUNE 30TH, 1891.

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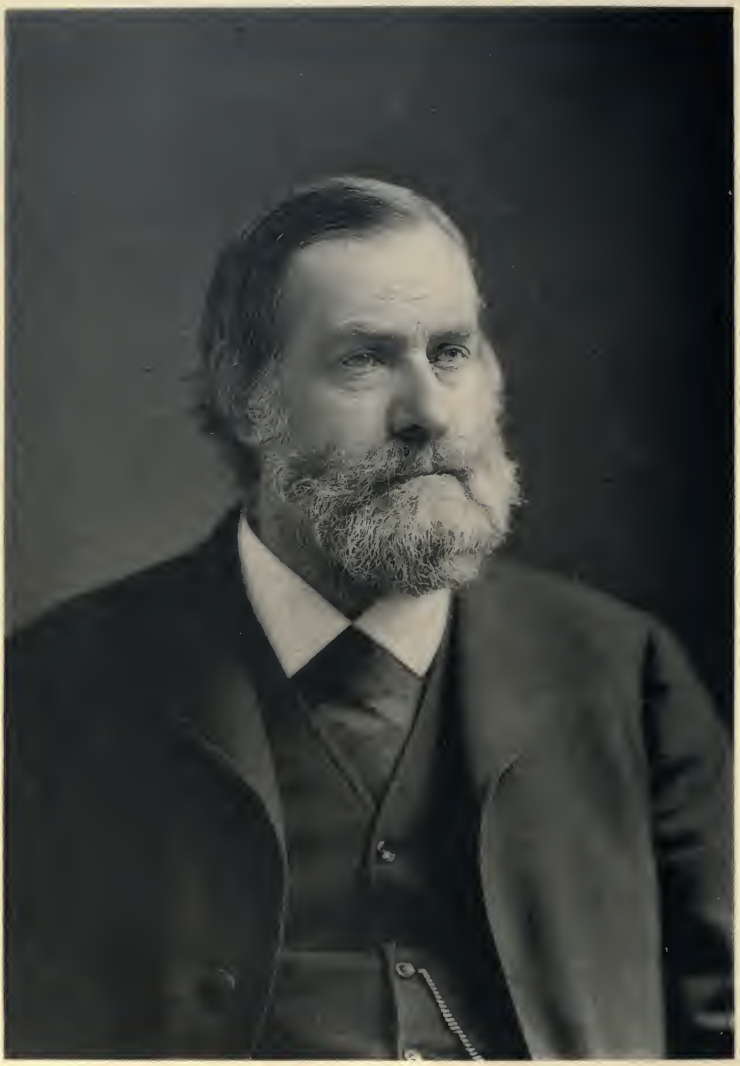
ACADEMY OF NATURAL SCIENCES,
1891.



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"And this our life, exempt from public haunt, finds tongues in trees, books in the running brooks, sermons in stones and good in everything."

It falls to the lot of but few, living in the midst of a great community for nearly three score years and ten, to have never made an enemy during that long period, but to have gained universal affection, esteem and respect. Yet such may in truth be said of the subject of this memoir.

The ancestors of Dr. Joseph Leidy were of French-German extraction and came to this country as missionaries. Mr. Philip Leidy, his father, was born in Montgomery County, Penna., December 5, 1791, and removed, when a young man, to Philadelphia, where he engaged in the trade of a hatter. He soon retired from business in which he had been unusually successful.

He married Catherine Melick, a descendant of the well known Melick family, the founders of the celebrated "Old Farm" in New Jersey.

Joseph Leidy, the third of four children by this marriage, was born September 9th, 1823, in Philadelphia, at his father's house, No. 312 N. 3rd. St., which is still standing. When but a year and a half old, he experienced in the death of his mother a loss that would be usually and justly regarded as irreparable. His father, however, in marrying shortly afterwards, Christiana, the sister of his first wife, gave to Joseph, a step-mother it is true, but one who never knew any difference between him and her own children. He loved her as a mother, for as he said upon one occasion, "I knew no other mother; to her I owe every advancement in life."

His early education was obtained at private schools. While still a child, he showed an appreciation of natural objects, taking particular interest in minerals and plants. The boy, however, had early evinced such remarkable ability as a draughtsman that his father had taken him away from school when about sixteen years of age with the intention of educating him as an artist.

At about this period, the youth passed much of his time in a wholesale drug-store near his home. Such good use did he make of

the opportunity there presented of learning the nature of drugs and the art of compounding medicines, that the proprietor recommended him as competent to take temporary charge of the retail drug-store of a customer. The success attending his conduct of the business was such as to make him consider it seriously, as a means of livelihood. The dissection of a few cats, dogs and chickens had, however, in the mean time, developed an interest in the study of anatomy and he had shown such an aptitude for dissection that Mrs. Leidy, proud of Joseph's talents and ever watchful of his interests, made up her mind that her son should become neither an artist nor an apothecary, but a physician. As Dr. Leidy said fifty years afterward in referring to the circumstances connected with his taking up the study of medicine as a profession: "My father intended I should be an artist, but my mother said that her children should learn the professions. She, being the stronger, carried the point."

In the year 1842, at the age of nineteen, Joseph Leidy began the study of medicine at the University of Pennsylvania, his preceptors being Dr. Paul B. Goddard and Dr. James McClintock. He presented to the Faculty a thesis on "The Comparative Anatomy of the Eye of Vertebrated Animals" and having complied in other respects with what was in those days deemed essential as a pre-requisite to graduation, in 1844 he received the degree of Doctor of Medicine. He at once began the practice of his profession, to which he devoted himself about two years. During that period, and even before, he had worked in the laboratory of the celebrated Dr. Robert Hare, and had assisted Dr. Goddard who was then Demonstrator of Anatomy at the University. Becoming impressed with the grave responsibilities incurred in the practice of medicine, of the demands on the time of the successful practitioner and the little leisure left to him for study, Dr. Leidy finally decided to give up the practice of medicine, with all hope of its emolument, and to devote his life entirely to study and teaching, trusting that eventually, in the attainment of a Professorship, he would obtain at least the means of livelihood.

Haud facile emergunt, quorum virtutibus obstat res angusta domi. For some time, young Dr. Leidy experienced that struggle with hardships and obstacles, incidental to the lives of so many great men, which talent, when accompanied with hard and continuous work, alone overcomes. While a student, however, Dr. Leidy, by his skill in

dissecting, had impressed Professor Hornor most favorably and he was, therefore, shortly after his graduation, appointed to the position of Prosector to the chair of Anatomy.

During the summer of 1845 Dr. Leidy was elected a member of the Boston Society of Natural History, a compliment greatly appreciated, he being so young a man. A few weeks later, on the evening of July 29th., he was elected a member of the Academy of Natural Sciences of Philadelphia, with which institution his name was inseparably connected until the day of his death. Through the opportunities for advancement liberally afforded by this society, he was enabled to accomplish the scientific work of his life. Shortly after becoming a member of the Academy, he was elected Librarian, which position he held for twelve months, and so efficiently were his duties performed that on the expiration of his term of office a vote of thanks was tendered him. Vacating the office of Librarian he was elected one of the Curators. At the annual meeting in 1847, he made his first report as Chairman of the Board of Curators, a position he held continuously until the time of his death, a period of forty-four years. During his years of membership, Dr. Leidy, until almost the close of his life, attended regularly the Tuesday evening meetings of the Academy. The Proceedings and Journal giving ample evidence of the number, variety and value of his contributions to all branches of natural science during that long period.

In the year 1846, he left the University for a time, having been elected Demonstrator of Anatomy in the Franklin Medical College. After one session at that institution he returned to the University and was again associated with Dr. Hornor. At this time he also gave a private course of lectures on anatomy, which attracted considerable attention.

During the spring of 1848 Dr. Leidy accompanied Dr. Hornor to Europe, visiting England, France and Germany. On his return he began a course of lectures on histology and in the following spring lectured on physiology at the Medical Institute. Incessant application, however, threatened him with serious illness, and although ambitious and full of enthusiasm he was obliged to give up all work for some months. He was elected a member of the American Philosophical Society in 1849. The late Dr. George B. Wood having been elected to the chair of Practice of Medicine in the University, went abroad the same year for the purpose of making

a collection of models, specimens, drawings, etc., with which to illustrate his lectures and invited Dr. Leidy to accompany him, knowing that he would be of great assistance in selecting the collection required. This visit, as well as the previous one abroad, was of the greatest possible advantage to Dr. Leidy, as he was not only afforded the opportunity of seeing the great museums of Europe under most pleasant auspices, but also of making the acquaintance and acquiring the friendship of such distinguished anatomists and physiologists as Owen, Majendie, Milne Edwards, Hyrtl, Johannes Müller, and many others.

On his return home, with health restored and spirits renewed, he took up again with enthusiasm his work as Prosector at the University. During this year, 1851, he was elected a member of the College of Physicians, and in 1852 he was appointed to the position of Pathologist to St. Joseph's Hospital.

The health of Professor Hornor having in the mean-time been much impaired, he was unable to continue his course of lectures during the winter of 1852. He requested the Board of Trustees to appoint Dr. Leidy his substitute. So admirable were the lectures then delivered, and so satisfied were the students with Dr. Leidy as a teacher, that upon the death of Dr. Hornor, in 1853, the substitute, though then but thirty years of age, was elected Professor of Anatomy in the University. This position he held with the most distinguished success till his death, a period of nearly forty years. His lectures were lucid, graphic and practical, and were listened to by the students, by whom he was beloved and respected, with the most profound attention. No attempt at oratory was ever made, no rhetorical flourishes were ever indulged in, the instruction being of the simplest character, but of the highest scientific excellence. Many were the anecdotes and amusing stories told of the Professor by the students, but they always redounded to his fame, and usually illustrated his wonderful knowledge of the structure of the human body. It was universally conceded that he was the highest authority on the subject of human anatomy in this country, and it may be added was equalled by few abroad, surpassed by none.

About this period the subject of paleontology attracted Dr. Leidy's especial attention, and, as we shall see when considering his scientific work in detail, much of his time was now devoted to its study.

In 1854 he became a member of the Publication Committee of the Academy, upon which he served continuously to the time of his death, being chairman of the same since 1867.

The civil war breaking out, he was appointed Surgeon to the Satterlee Military Hospital, his youngest brother, the late Dr. Philip Leidy, so beloved by his comrades, taking a most active part during four years as surgeon in the field. It was at the Satterlee Hospital that the opportunity was afforded of obtaining many of the beautiful preparations illustrative of his lectures on human anatomy and of making important post-mortem examinations, the reports of which were published in the "Medical and Surgical History of the War."

Upon the organization of the National Academy of Sciences in 1863, he was elected one of the members.

In 1864 Dr. Leidy married Anna, daughter of Mr. Robert Harden. The union was a most happy one. Not being blessed with children, they some years later adopted Alwinia, daughter of the late Professor Franks of the University of Pennsylvania. Dr. and Mrs. Leidy at once became so much attached to their little daughter, and she so devoted to her parents, that it seemed as if the love that had been so freely given to the son by his foster mother was now to be lavished by him upon his adopted daughter.

In 1871 Dr. Leidy was elected Professor of Natural History in Swarthmore College, a position for which he was eminently qualified, and which he filled to the entire satisfaction of the managers and friends of that institution. His simple, attractive way of imparting his vast knowledge of nature, fairly captivated the students and stimulated in them a love for natural science, one result of which was constant but unsuccessful attempts to find an object in nature unknown to their teacher.

In the year 1875, accompanied by his wife, he went abroad for the third time and while renewing the friendships made on previous visits, he made many new friends among the leaders of thought in London, Berlin and Paris.

On the re-organization of the Zoological Society and the establishment of the Zoological Garden in 1876, Dr. Leidy was elected one of its Directors, holding the position till his death. Though not a regular attendant at the meetings of the Board, he took an active interest in the welfare of the Society, and was ever ready to give the benefit of his advice, when asked to do so. Indeed his last

official act, one week before his death, was his attendance at the meeting of the Board of Directors of the Zoological Society, May 24th, in response to a request to be present. On that occasion he spoke in reference to certain matters of importance then under consideration.

As a fitting recognition of the services rendered by Dr. Leidy to the Academy of Natural Sciences of Philadelphia, he was unanimously elected its President in 1881. This position he held at the time of his death.

The Biological Department of the University of Pennsylvania having been established in the year 1884, he was made its Director and was also elected to the position of Professor of Zoology and Comparative Anatomy. The latter appointment was a most congenial one, as it afforded him the opportunity of delivering a systematic course of lectures on those subjects to the study of which he had devoted the best years of his life. As a further proof of the respect and esteem in which he was held by his townsmen, it should be mentioned that in the following year, 1885, he was elected President of the Wagner Free Institute of Science.

In the year 1886 Harvard University honored him by conferring upon him the degree of Doctor of Learning and Laws.

Not often has a prophet been honored in his own country as was Dr. Leidy. That his services to science, however, were not over-estimated by his personal friends and admirers, is shown by the honors conferred upon him by the learned societies abroad, among which was membership in the following, not already referred to. The list is probably incomplete:—

Naturhistorischer Verein für das Grossherzogthum Hesse und Umgebung, 1848; American Academy of Arts and Sciences, 1849; Société de Biologie, Paris, 1851; Medical Society of Virginia, 1852; Linnean Society of Pennsylvania College, Gettysburg, 1853; Société Impériale des Naturalistes de Moscow, 1853; Logan Institute, Virginia, 1853; Zeosophical Society of the University of Pennsylvania, 1853; Philomathian Society of the University of Pennsylvania, 1854; Société des Sciences, des Arts et des Lettres du Hainault, 1854; Dallas Historical Society, 1855; Iowa Lyceum, Des Moines, 1855; Natural History Society of Charleston, S. C., 1855; Academy of Sciences, St. Louis, Mo., 1856; K. Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher, 1857; Zoological Society of London, 1857; K. Baierische Akademie der Wissen-

schaften, 1858; Dublin University Zoological and Botanical Association, 1859; Burlington County Lyceum of History and Natural Sciences, 1859; K. Böhmische Gesellschaft der Wissenschaften, 1860; R. Accademia economico-agraria dei Georgofili di Firenze, 1861; K. K. Zoologisch-botanischer Verein, Wien, 1861; Geological Society of London, 1861; Dublin Natural History Society, 1863; Minnesota Historical Society, 1863; Entomological Society of Pennsylvania, 1864; College of Physicians and Surgeons, Reading, 1870; Anthropological Society of London, 1872; Linnean Society of London, 1872; Minnesota Academy of Natural Sciences, 1873; Société Nationale des Sciences Naturelles de Strasbourg, 1873; Sociedad Mexicana de Historia Natural, 1874; Literary and Philosophical Society of Liverpool, 1877; Historical Society of Pennsylvania, 1884; Biological Society of Washington, 1884; New York Microscopical Society, 1884; K. Danske Videnskabernes Selskab, 1886; Essex Institute, 1887; Victoria Institute, or Philosophical Society of Great Britain.

Of the many honors conferred upon Dr. Leidy by the societies of this country and abroad, none surprised him as much as the awarding to him, by the Boston Society of Natural History, of the Walker prize of $500, which on this occasion was raised to $1000 as a special recognition of his services to science. He was also the recipient of a prize from the Royal Microscopical Society in 1879, and he was awarded the Lyell medal by the Geological Society of London in 1884. The Academy of Sciences of Paris deemed him most worthy of the Cuvier medal in 1888.

Dr. Leidy went abroad in the summer of 1889 for the fourth and last time, accompanied by his wife and daughter. Unfortunately his wife's serious illness while in London, marred considerably the pleasure of the visit. Nothing could have exceeded the attention and kindness of the medical gentlemen of London whom Dr. Leidy consulted under these trying circumstances. He declared on his return that no more could have been done for his wife and himself had they been at home.

There now remains for the memorialist but little to add to what has already been said. A long, pure and useful life was drawing to its close. During the past year it had become painfully apparent to those most attached to Dr. Leidy that the end was near. Though weary in mind and sick in body, the brave old man struggled on, proudly disdaining to ask assistance in doing what he regarded as

his duty. His death, which occurred April 30th, 1891, was precipitated by the severe strain experienced in the performance of his last official professional duties. No language can express the loss the members of the Academy felt that they had sustained in the death of their President. The regret was universal, sincere, heartfelt; the one wish expressed being to pay every possible respect to the memory of their distinguished associate.

In endeavoring to portray the personal character of Dr. Leidy, the disposition to indulge in unrestricted eulogy becomes almost irresistible, for the author, like his other friends, found in him no faults, or if any, only such as were peculiar to a highly sensitive, emotional and amiable nature.

That which invariably impressed all who came in personal contact with the great naturalist, was not so much his vast and extraordinary knowledge of nature, as the modest and simple way in which he described the rocks, plants and animals with which he was so familiar. His unaffected humility, simplicity and entire absence of self-assertion or conceit never failed to attract and charm those with whom he was thrown in contact. His whole nature was such as to inspire the utmost confidence, to make every one instinctively feel that he was incapable of deceit or meanness of any kind. The sterling integrity of his character was as preëminently manifested in his daily as in his professional life. So charitable and kindly was his nature that strife of any sort was most repugnant to him. Indeed so much was this the case that in some instances he submitted to what his friends regarded as injustice or imposition rather than engage in contention or discussion. Though an indefatigable worker and one of the closest of students, Dr. Leidy was far from being a recluse. On the contrary, no one more thoroughly enjoyed in a moderate way, the society of his friends or contributed more to the success of a social entertainment. As a relaxation from his work he was at one time fond of attending the theatre, and he occasionally read a novel with the same end in view, although general literature had for him but little attraction.

While the life of Dr. Leidy regarded from the ordinary standpoint was uneventful, it offers the rare instance of one steadfastly and unselfishly devoted to the study of nature; of a long and useful career unsullied by a stain and characterized as much by its sweetness, simplicity and goodness as by its great mental achievements.

Within the limits of this memoir the author can only indicate the salient features of Dr. Leidy's scientific work, the discoveries upon which were founded his great reputation at home and abroad, and upon which his future fame as America's most distinguished biologist will probably rest.

While he never regarded himself either as a mineralogist or a botanist, yet those actively engaged in the study of minerals or plants were always glad to avail themselves of his advice in the pursuit of their investigations; indeed so true was this as regards precious stones, that jewellers of long experience never questioned his estimate of the value of the gems frequently submitted by them to his inspection.

His familiarity with minerals in general was frequently shown at the weekly meetings of the Academy, when, as Curator, he called attention in an impromptu way to the additions presented during the meeting to the mineralogical cabinet. Among such verbal communications may be mentioned his remarks upon the minerals from Mount Mica, the tourmalines; specimens of corundum from North Carolina; the mineral springs of Wyoming and Utah; the eroding and polishing of quartzite and jasper by the conjoint action of wind and sand; ozocerites from the Carpathian Mountains; topaz from Brazil and Siberia; precious opal; rocks from South Mountain; the origin of citrine or yellow quartz, &c.

In this connection it may be stated that the valuable collection made by him has been purchased by the Government, and will be preserved in the National Museum at Washington. As with the minerals, he would, as occasion offered, comment informally on an interesting plant. In this manner communications were made on *Wolffia Columbiana*, the smallest and simplest of all the true flowering plants, only comparatively recently known to occur in the United States, and on *Chara* and *Vallisneria*. The hairs of the Mullein being under discussion he described the intra-cellular circulation in plants. His intimate acquaintance with botany was also shown by the constant allusions made to the various kinds of plants noticed in the different parts of the country visited by him in search of minerals or fossils. The herbarium which he presented to the Biological Department of the University contains over 1500 species of plants, collected and determined by himself.

Of the many contributions to natural history made by Dr. Leidy, his observations upon the lower forms of life deserve

especial notice, on account of their originality and value, and as illustrating his remarkable ability as a microscopist and skill as an anatomist and artist. For many years on different occasions, while investigating with the microscope the minute creatures found in the streams and ponds of the neighborhood, he, like others, had incidentally noticed the presence of various forms of minute animated beings consisting simply of protoplasm and called rhizopods on account of their continually protruding and retracting their bodies in a root-like or rhizome manner. They often form shells of great beauty and variety. Becoming especially interested in these low forms of life, he determined to lay aside all other work, and to devote himself entirely to the study of these minute beings. So studiously did he adhere to this resolution, that for several years he allowed nothing to interfere with this especial study. With the object of collecting material, he visited ponds, ditches and streams in this and other States, examining also the mould on stones and between the bricks of houses, and then patiently observed with the microscope, and delineated with a master hand, the protean amœba-like changes exhibited in the life history of these wonderful beings.

The result of this incessant and arduous labor was the production of the magnificent monograph "Fresh Water Rhizopods of North America," which appeared in 1879 as one of the Reports of the United States Geological Survey of the Territories.

To those wishing to engage at some future time in similar researches it may not prove uninteresting to know that this great work was accomplished by means of a microscope that cost $50, provided with but two objectives of moderate magnifying power. In the sediment of a few drops of water squeezed from a piece of moss, thirty-eight different kinds of rhizopods, together with examples of *Micrasterias*, *Euastrum*, *Docidium*, *Closterium* and other desmids, together with several species of diatoms, were revealed by this simple apparatus.

Notwithstanding that Dr. Leidy invariably made use of very simple instruments in his microscopical investigations, he rarely made mistakes, though the first to admit such when substantiated. In this connection, it may be appropriately mentioned, that his observation made in 1861, that the Gregarina, a minute unicellular entozoon, infesting the stomach of the cock-roach and other insects, was provided with muscular fibres, was questioned by European micro-

scopists, and indeed, was denied by the elder Van Beneden. Thirty years afterward, the observation was fully confirmed by the investigations of the younger Van Beneden, who admitted that he must agree with Dr. Leidy, even at the expense of his father's accuracy.

Among the simple forms of animal life, though more highly organized than the Rhizopods and Gregarinæ, the sponges attracted Dr. Leidy's attention. Among the more interesting forms described by him, may be mentioned *Pheronema Annae*, so-named in honor of his devoted wife. He was the first to correctly describe the position which that exquisite siliceous sponge, the *Euplectella* of the Philipines, assumes in a state of nature and the manner in which it is anchored by its strands, a reversed position having been previously assigned to it by the greatest of English anatomists. The beautiful hydroid, *Eucoryne elegans*, resembling a minute rose bush, was dredged up by Dr. Leidy, in the bay of Newport. This, together with sponges and other marine animals, supplied the material for his paper in the Journal of the Academy entitled: "Marine Invertebrate Fauna of Rhode Island and New Jersey." *Urnatella gracilis*, a peculiarly interesting fresh water polyzoon was discovered by Dr. Leidy in the Schuylkill river just below the Fairmount dam. Its body wall is so translucent as to permit movements of the alimentary canal to be seen under the microscope. The mouth of the polyp-head or bell is surrounded with a circle of ciliated tentacula. It is described and beautifully illustrated in the Journal of the Academy.

While investigations like those just referred to are of interest to the biologist, his researches in helminthology appeal also to the medical profession and the entire community on account both of their scientific and practical value. The discovery, by Leuckart, of the cause, and therefore of the mode of prevention, of trichinosis in man, was entirely due, as that eminent authority himself says, to the discovery by Dr. Leidy of *Trichina spiralis* in the pig.

As far back as 1846, one morning while at breakfast, just as he was about to partake of a piece of pork, Dr. Leidy noticed that it contained minute peculiar specks, which after submitting to microscopic investigation, he recognized as being encysted Trichinæ. The account of this observation, published in the Proceedings of the Academy, attracting the attention of Leuckart, it occurred to the distinguished German helminthologist that trichinosis in man might be due to the eating of raw pork containing trichinae. This was after-

wards shown to be the case. Dr. Leidy's reputation as a helminthologist was world wide, and his numerous contributions to that subject are held in the highest esteem abroad, being continually referred to in the standard works of Diesing, Leuckart, Cobbold and others. Throughout the United States he was regarded as the highest authority on entozoa and parasites. Physicians from all parts of the country were constantly sending to him for determination, flukes, tape and thread worms, trichinae, ticks, etc., in the hope of securing suggestions from him as to the best means of preventing the recurrence of parasites in their patients.

His "Observation on the Parasites of the Termites or White Ants" published in the eighth volume of the Journal of the Academy, was directly in this line of investigation. His memoir entitled, "A Flora and Fauna within Living Animals," constituting part of the Smithsonian Contributions to Knowledge for 1853, had already established in the most striking manner, the fact that the alimentary canal of many animals such as beetles, cock-roaches and centipedes, are the natural homes of a most diversified animal and vegetable life. Indeed the mucous membrane of the intestines of certain beetles presents the appearance of a flower garden. The description of *Enterobryus* led Prof. Robin to the later discovery of the species in the *Julus terrestris* of Europe.

The work just referred to is not only a remarkable one as having revealed to the naturalist a number of new forms of animal and vegetable life living parasitically within the bodies of higher animals as their hosts, but as containing the most profound reflections, the truth of which modern research has confirmed in every particular, upon the origin and extinction of life upon the earth. In speaking of the origin of entozoa and entophyta at page 9 of the paper under consideration, the author observes: "The study of the earth's crust teaches us that very many species of plants and animals became extinct at successive periods, while other races originated to occupy their places. This probably was the result, in many cases, of a change in exterior conditions incompatible with the life of certain species and favorable to the primitive production of others. . . . . Living beings did not exist upon earth prior to their indispensable conditions of action, but wherever these have been brought into operation concomitantly, the former originated. . . . . Of the life, present everywhere with its indispensable conditions, and coeval in its origin with them, what was the immediate cause? It could not

have existed upon earth prior to its essential conditions; and is it, therefore, the result of these? There appear to be but trifling steps from the oscillating particle of inorganic matter to a Bacterium; from this to a Vibrio, thence to a Monas, and so gradually up to the highest orders of life! The most ancient rocks containing remains of living beings, indicate the contemporaneous existence of the more complex as well as the simplest of organic forms; but, nevertheless, life may have been ushered upon earth, through oceans of the lowest types, long previously to the deposit of the oldest palaeozoic rocks as known to us!!"

Although, unfortunately for science, he rarely indulged in such speculations, it may well be asked where in the whole range of biological literature can there be found a more concise and fitting statement of what is known as the theory of Natural Selection, Survival of the Fittest or, in a word, of Darwinism, than is expressed in the above quotation. Prophetic words indeed: the "Origin of Species" appeared five years later.

As a further illustration of the wide range of his biological studies may be mentioned his knowledge of entomology. This was shown in a most happy manner some thirty years ago by his reply to the Councils of Philadelphia, in answer to their inquiries as to the best methods of protecting the shade trees of the city from the depredations of insects. Perfectly familiar with the structure, development and habits of the canker worm, the scale bug, the tufted caterpillar, the sack bearer, and the borer, the insects that are most destructive to our shade trees, he suggested various simple but effective methods by which the insects could be destroyed with least injury to the trees.

One would not suppose that the subject of "basket worms" would be suggestive of poetical ideas, yet in speaking of the development of the insects, he observes that, from the pupa case "is produced the moth, the male of which awaits the night to leave his habitation in search of a mate. The female never leaves her silken dwelling, nor does she even throw aside her pupa garment: it is her nuptial dress and her shroud."

Minute butterflies were always interesting to him, and the collection he made many years ago is still a very attractive feature in the entomological collection of the Academy.

Among his most important contributions to the anatomy of insects should be mentioned his account of the structure of the walk-

ing-stick insect, *Spectrum femoratum*, communicated to the Academy in 1847, and his description of the mechanism by which the membranous wings of the locust are closed. The anatomy of the hemipter, *Belostoma*, then a rare insect, but lately quite commonly attracted by the electric light, was the subject of a communication appearing in the Journal of the Academy. The admirable figures in that paper, as well as those illustrating the internal anatomy of the neuropterous insect *Corydalus cornutus* in its three stages of existence are to this day made use of by such high authorities as Packard and others to illustrate their standard works on entomology.

One of the most important of Dr. Leidy's observations upon the structure of articulate animals was his discovery in 1848 of eyes in barnacles, *Balanus*. It is especially interesting in this connection to note the fact that Darwin remarks in his monograph on the Cirripedia, p. 48, "owing to Professor Leidy's discovery of eyes in a Balanus, I was led to look for them in the Lepadidæ."

During the same year there appeared in the American Journal of the Medical Sciences his researches upon the comparative anatomy of the liver. This communication is based upon the study of the organ in numerous invertebrate and vertebrate animals and the view is advanced that its structure is essentially the same in all orders of animals. According to our author's theory, the liver consists of more or less numerous membranous tubes or cæcalined with cells whose office it is to elaborate the bile from the blood supplying the organ. As the bile so elaborated passes from the cells into the spaces between them, and as these intercellular spaces are continuous with the interior of the inter-lobular biliary duct, they must be regarded as the beginning thereof. The intimate structure of the liver does not differ then in any way from that of any other true gland, the simplest expression of which is a basement membrane separating a blood-vessel from a secreting cell. This view of the structure of the liver was accepted by but few of the anatomists of the day. It has, however, been shown by later study that the liver begins as a diverticulum of the intestine in which the relation of the basement membrane to the blood-vessels and secreting cells is the same as that indicated by Dr. Leidy. Further modern investigation has shown that the liver contains more urea than any other gland in the body, thus confirming the opinion as to the biliary function of the tubes opening into the intestines of insects and which have been

usually regarded as renal by most anatomists on account of their containing uric acid and sodium urate.

In 1844, Dr. Leidy, then twenty-one years of age, was asked by Dr. Amos Binney, of Boston, to contribute an article on the special anatomy and physiology of the terrestrial gasteropoda of the United States for the proposed general work on that subject then in preparation by the latter. Before the special anatomy was completed, the death of Dr. Binney, unfortunately, put a stop to further work in that direction. Nevertheless, the result of Dr. Leidy's investigations were later published in Binney's work on the terrestrial gasteropoda of the United States, as edited by Gould. To appreciate the importance of this admirable monograph, beautifully illustrated from drawings by the author, it must be remembered that at the time of its appearance, the only systematic work on the anatomy of the mollusca was Cuvier's classical treatise published in 1817. While it is true that there are some errors of interpretation in Dr. Leidy's paper, recognized later by the author, yet to this day it is in the hands of every specialist and is continually referred to in the standard works on the anatomy of the mollusca. In this connection it is an interesting fact that the first scientific communication of any kind, made by Dr. Leidy, at least as far as known to the writer, was a paper on the anatomy of *Littorina angulifera* submitted July 16th, 1845 to the Boston Society of Natural History and published in the Journal of that Society, no doubt on account of Dr. Binney's interest in the author.

The latter was not then a member of the Academy of Natural Sciences of Philadelphia, but being elected a few days later, July 29th, he presented, on the 14th day of the following October, his first communication, "Notes taken on a Visit to White Pond, N. J." The extinct mollusca described in the paper may still be seen in the Museum of the Academy. These specimens are interesting not only as constituting the subject of his first communication to our society, but as offering one of the few instances of descriptions of fossil invertebrata to be met with in Dr. Leidy's numerous paleontological works. It need not be added, however, that his knowledge of the extinct forms of invertebrate life was as extensive and exact as was his acquaintance with recent forms.

When he began his biological studies, the waters of every ditch, stream, and pond in the vicinity of the city, teemed with various kinds of invertebrate life, unfortunately since destroyed by sewage

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and coal oil. Many of these were new to science and constituted, as we have seen, the subject of most of his researches upon the anatomy of the invertebrates. The opportunities afforded at that time for investigating the anatomy of vertebrates, other than the most common forms, were very limited, depending, as the Zoological Garden had not been established, upon the chance of a travelling menagerie losing a specimen by death while exhibiting in the city.

His contributions to our knowledge of the anatomy of recent vertebrates were, therefore, few in number. Among these may be mentioned his communication in the Proceedings of the Academy, illustrated with figures, on certain peculiar bodies resembling the Pacinian corpuscles of man, found along the course of the intercostal nerves in the boa constrictor. The anatomy of the abdominal viscera of the three-toed sloth, the subject of another communication to the Academy, is interesting as containing a description and figure of the embryo sloth with membranes.

In 1852 there appeared in the Journal of the Academy his important memoir "Description of the Osteological Characters of a New Genus of Hippopotamus." By a comparison of the skulls in the Museum of the Academy, the author proves that the animal from Liberia not only differs from that of the Nile, as had been previously supposed by Dr. Morton, but that it belongs to a different genus, which he named at first *Chærodes*, but afterward *Chæropsis*, the former name having been already adopted for an insect. It is an interesting fact that while his opinion of the generic distinction of *Chæropsis* from *Hippopotamus* was not accepted by the zoologists of that day and is questioned by many even now, its correctness has been fully established by the recent researches of one of the highest authorities, Prof. Alphonse Milne Edwards.

Dr. Leidy's contributions to the general or histological anatomy of vertebrates were but few in number. Mention should be made, however, of his communications to the Academy and to the American Journal of Medical Sciences, on the development of the Purkinjean corpuscles of bone, the structure of the intercellular substance of articular cartilage, and the disposition of the sheath of muscular fasciculi. Dr. Leidy, in the paper first mentioned, showed that the bone cells, or Purkinjean corpuscles, are derived from the pre-existing cartilage cells, the canaliculi being prolongations or protrusions of the cell wall. As regards the structure of the intercellular substance of articular cartilage, basing his observations on the fact

that the latter fractures in a direction perpendicular to its surface, he showed that it consists of extremely fine, transparent filaments, upon the existence of which depends the disposition of the cells in rows. He also demonstrated that the filaments of fibrous tissue forming the sheath of muscular fasciculi are disposed diagonally around the latter, becoming straight at their rounded extremities. He pointed out the advantage, functionally, of such arrangement, by which the muscular power is conveyed to the parts to be moved without entailing any loss.

As an illustration of the extent and variety of his researches in histology, it may be mentioned that about this period he translated from the German, Gluge's Atlas of Pathological Histology, a standard work at that time.

Dr. Leidy's studies of the structure of the human body were fully set forth in his admirable treatise upon human anatomy, so that he but rarely published any special communications upon that subject. His researches, however, upon the development of the intermaxillary bone in man, the structure and development of the temporal bone, the nature and relations of the crico-thyroid membrane and adjacent muscles of the larynx are well worthy of consideration. To Goethe, great alike as philosopher, poet and naturalist, science is indebted for the discovery of the intermaxillary bone in man. Its recognition, however, at the time Dr. Leidy began his study, had been confined to abnormal conditions due to an arrest of development, as in hare-lip, its exact limits and the period of life in which it occurs as a distinct piece not having been accurately determined. He made it the subject of a special investigation. The result of his study, based upon the examination of a number of human embryos, was embodied in his observations on the existence of the intermaxillary bone, in which not only was its development accurately described, but it was shown that the same law governed the formation of the upper maxillary bones in man as in all other vertebrates.

It would hardly be supposed at the present day, considering all that has been published on the development and structure of the temporal bone, that anything of importance would have been left unsaid. As recently, however, as 1883, Dr. Leidy communicated to "Science" the results of his study of that portion of the skull. He prefaced his description with characteristic modesty by observing that he laid no claim to having made any discoveries. Nevertheless his views as to the development and relations of the auditory plate,

the scute, the antrum and attic, based upon beautiful preparations, differ so essentially from those given in systematic treatises that it may be truly said he has thrown a flood of light upon the anatomy of that most complex of bones. It should be mentioned in this connection that while he admits, with Prof. Huxley, the presence of two ossificatory centers in the development of the temporal bone, the proötic and opisthotic, he views the so-called third centre or epiotic bone, not as a distinct centre, but as a continuous out-growth of the posterior semicircular canal.

He was one of the few anatomists who described the vocal membranes of the larynx as being membranes instead of cords. The latter name, most inappropriate and misleading, was originally given to them because it was supposed that the voice was produced in the same manner as sounds are produced by the vibration of strings, whereas the larynx is rather comparable to a reed instrument, such as the oboe.

In an excellent paper, well illustrated, he described accurately the structure and attachments of the crico-thyroid membrane as well as the relations of the adjacent muscles, more particularly of the thyro-arytænoideus, and thyro-epiglottidæus, the superior and inferior arytæus epiglottidæus.

The first edition of the "Elementary Treatise on Human Anatomy" was published in 1861. It is one of the best works ever offered to the medical profession on the subject, and more than fulfilled its author's anticipations of usefulness. The work was prepared, not in the hope that it would supersede the classical treatises already before the profession, but to place in the hands of students and practitioners of medicine a work on human anatomy which, while brief and clear, should be sufficiently complete for all practical purposes. The description of the various organs, illustrated by excellent figures, many of them original, is always lucid and graphic. Especially is this true of the observations upon general histology, usually prefacing the descriptions of great systems such as the muscular, alimentary, nervous systems, etc. One of the striking features of the work is the employment in the text of the English name only for the part to be described, the Latin or other synonyms being given in foot notes, thus greatly simplifying the nomenclature. The work throughout bears the impress of the comparative anatomist, of one as familiar with the structure of an infusorial animalcule as with that of the complex vertebrate.

The variety, extent and exactness of Dr. Leidy's knowledge of nature was unsurpassed, if equalled, by that of any living naturalist. It was this familiarity with all natural objects which invariably impressed those brought in personal contact with him. If some minute infusorian were casually mentioned in conversation, one would have supposed from his remarks that he had devoted his life to the study of the Protozoa; an intestinal worm being the subject of discussion, from his description of its structure, origin and mode of life, it would have been inferred that helminthology was his exclusive specialty. The opportunity of seeing him dissect an insect, mollusk or vertebrate, would soon convince one that he was a most skilful anatomist. A fragment of rock, a plant, a shell submitted to him called forth criticisms worthy of the professional mineralogist, botanist or conchologist.

Profound as was his knowledge of living plants and animals, it can be truly said that his acquaintance with the extinct forms of life was equally so. Indeed it was his great familiarity with the existent types of vegetable and animal life that so eminently qualified him to determine fossil forms.

In the year 1847 Dr. Hiram A. Prout of St. Louis, published in the American Journal of Science and Arts the description of a fossil maxillary bone of *Paleotherium*, from near White River, Nebraska. This communication at once directed the attention of geologists and paleontologists to the Mauvaises Terres.

At about the same time Dr. S. D. Culbertson of Chambersburg, Penna., submitted to the Academy of Natural Sciences of Philadelphia, some fossils sent to him from the Bad Lands of Nebraska by Mr. Alexander Culbertson. These were afterwards presented to the Academy by the collector and described by Dr. Leidy in the Proceedings, together with the paleotheroid form just referred to from the same locality.

The collection of fossils, in the possession of Prof. O'Loghland, of St. Louis, as well as those made in the Bad Lands of Nebraska by Dr. Evans, at the request of Dr. Owen of the Geological Survey of Nebraska and by Captain Van Vliet of the U. S. Army, were also placed at Dr. Leidy's disposal for description in the Proceedings of the Academy. The late Prof. S. F. Baird, fully appreciating the importance of the discoveries, sent Mr. T. A. Culbertson to the Bad Lands of Nebraska. He returned with a most valuable collection of mammalian and chelonian fossils. These

specimens, with others obtained from the same locality, were sent to Dr. Leidy by Prof. Baird, who, with his characteristic judgment, remarked that Dr. Leidy, though but thirty years of age, was the only anatomist then in the United States qualified to determine their nature.

The finding of these fossils, together with the appreciation of their value and the recognition of their relations, constitutes a discovery which, if equaled, has never been surpassed in importance by any other contribution to paleontology.

The "Ancient Fauna of Nebraska" appeared in 1853. It contained descriptions of the fossil remains just referred to, together with some previous publications to be mentioned hereafter, and was the beginning of a most brilliant series of paleontological researches. They extended over a period of more than forty years and culminated in discoveries which, together with others made in the same field, are regarded by many as going farther to establish the doctrine of evolution than all the other facts hitherto advanced in favor of that theory. The remains of the extinct animals described in this work excited a great deal of attention when submitted to the Academy, as they were the first fossils brought from the tertiary beds of the West. They were of a more generalized type of structure than those living at the present day, a remarkable feature, especially in the case of the Tertiary mammalian remains discovered, some of which, to a considerable extent, bridged the gap between extinct and recent mammals. These facts, commented upon as so remarkable at the time, afterwards became perfectly intelligible in the light of the theory that the early tertiary mammals must be regarded as the ancestors of those living at the present day.

Among the ancient mammals from the tertiary beds of Nebraska described by Dr. Leidy, may be mentioned *Poëbrotherium*, a ruminant nearly allied to the musk deer and through *Procamelus*, described later by our author, the ancestor of the camel. *Agriochœrus* and *Oreodon*, peculiar ruminants, were especially interesting as filling up the interval between *Anoplotherium* of Cuvier and recent ruminants, as *Zeuglodon*, whose vertebræ were once so common in Alabama as to be used for fences, and which bridges the gap between the carnivora and the cetacea. *Oreodon*, intermediate in its structure between the hog, deer and the camel, appears to have lived in herds inhabiting the whole continent from Nebraska to Oregon. *Archeotherium*, a recent genus of suilline ungulata, was an illustra-

tion of the generalized type of mammals living in those early tertiary times combining ruminant with carnivorous characteristics.

The skull and jaws of the horse-like mammal *Anchitherium*, were particularly important as being the remains of a genus hitherto represented in Europe by other parts of the skeleton.

In view of what has since been established regarding the genealogy of the horse, it is interesting to find Dr. Leidy remarking that "it is extraordinary that *Anchitherium* should be so much like *Paleotherium* in the anatomical and physiological construction of its teeth, and yet be so much like the horse in its skeleton." *Titanotherium*, of which the lower-jaws, as already mentioned, were the the first fossils presented to the notice of the world from the great mammalian cemetery of the West, resembles, according to Dr. Leidy, the *Paleotherium* of Cuvier, though much larger than *Paleotherium magnum*. Later researches have shown that *Titanotherium* has affinities with *Limnohyus* and *Paleosyops*, afterwards described by Dr. Leidy, as well with *Brontotherium*.

Two species of *Rhinoceros* were described in the work as having once inhabited the Bad Lands of Nebraska, the largest of the two species being about three-fourths the size of *Rhinoceros Indicus* of the present day.

As an illustration of Dr. Leidy's remarkable knowledge of osteology even at that early date, it may be mentioned that he established this species of extinct Rhinoceros upon a few small fragments of molar teeth, without having even those of a recent Rhinoceros with which to compare them. The correctness of this determination was questioned when the teeth were first brought to the Academy, it being considered incredible that such an animal should have ever lived in Nebraska. His opinion, however, was fully sustained soon afterwards by the discovery of several entire molars together with a complete skull of the animal. Of the remaining mammalia described as occurring in Nebraska at that time should be mentioned *Machairodus*, recognized later as a synonym of *Drepanodon* or the sabre-toothed tiger, which had already been found in France, India and Brazil, and which no doubt preyed upon the herds of *Oreodon* roaming over the country in those remote times, much as the lion and tiger prey upon the deer in Asia and Africa at the present day.

A most striking peculiarity of the paleontology of the Bad Lands of Nebraska, is the fossil turtles to be seen by hundreds particularly

in the neighborhood of Bear Creek, which appears to have been at one time a vast lake. All the turtles from this region submitted to Dr. Leidy for determination appear to have been species of *Testudo*.

The "Ancient Fauna of Nebraska" is a very remarkable work not only on account of the admirable descriptions it contains of animals long since extinct whose existence on this continent, as in the case of the rhinoceros, had never been suspected, but particularly in view of the lack of opportunity to compare the fossil remains with those of recent animals. The identification of fossil remains, the determination of their relations and affinities, always present difficulties to the best comparative osteologists even when studied in connection with such magnificent collections as those of the Royal College of Surgeons or of the Jardin des Plantes. The accuracy of Dr. Leidy's work is, therefore, specially worthy of note as he had no material for comparison except that contained in the limited collections of the Academy; yet how comparatively few are the errors his successors have indicated.

The remains of the extinct gigantic sloths that inhabited North America during the quaternary period, and which probably were the ancestors of similar but smaller animals now living in South America, early attracted the attention of American naturalists. As long ago as 1797, Thomas Jefferson, in a communication to the American Philosophical Society, described certain bones discovered in a cave in Green Briar County, Virginia, which he regarded, on account of the claws, as being the remains of a carnivorous animal which he named *Megalonyx*. The bones being subsequently presented to the American Philosophical Society were again described by Dr. Wistar, who, basing his opinion upon the form and arrangement of the bones of the feet, suggested that *Megalonyx* was a kind of Sloth and not a carnivorous animal as Mr. Jefferson had very naturally supposed. An examination by the great paleontologist Cuvier, of casts of these bones sent to him by Mr. Peale, fully confirmed Dr. Wistar's opinion as to the sloth-like nature of *Megalonyx Jeffersoni*, as it was afterwards called by Dr. Harlan. The original specimen described by Mr. Jefferson, now in the Museum of the Academy, together with other remains of *Megalonyx*, *Megatherium*, etc., obtained from Tennessee, Mississippi, Kentucky, Alabama and Georgia, constituted the material upon which was based Dr. Leidy's admirable "Memoir on the Extinct

Sloth Tribe of North America" which appeared, beautifully illustrated, in 1855, two years after the publication of the "Ancient Fauna of Nebraska."

At the time that Dr. Leidy began his researches upon the extinct sloths considerable difference of opinion prevailed as to whether certain bones that had been discovered since the sloth-like nature of *Megalonyx* was satisfactorily determined were the remains of that animal or of one somewhat closely allied. Dr. Leidy showed conclusively that while several of the bones in question were those of *Megalonyx*, many that had hitherto been regarded as such were undoubtedly the remains of other extinct edentata such as *Gnathopsis*, *Mylodon*, *Megatherium*, *Scelidotherium*, etc., the generic and specific characters of *Megalonyx* being clearly indicated as well as those of the other edentata just mentioned, many of which had already been described by Cuvier and Owen. As an illustration of the exactness of Dr. Leidy's determination of the nature of *Megalonyx*, it may be mentioned that in his first description he attributed five toes to the hinder feet as well as to the fore feet, a greater number than is known to belong to any other genus of the Tardigrada. The correctness of this view was fully substantiated the following year by the discovery of remains of *Megalonyx* among which the particular bones of the feet that were missing in the specimens previously described happened to be represented. These were made the subject of some further observations upon the feet of *Megalonyx*.

The extinct fishes discovered in the Devonian deposits of Illinois and Missouri and the Devonian and Carboniferous formations of Pennsylvania now attracted his attention and were made the subject of special communications to the American Philosophical Society and the Academy.

Among these interesting remains from the red sandstone formation of Tioga County, Pennsylvania, discovered by Charles E. Smith, Esq. and described by Dr. Leidy, were those of *Holoptychius Americanus*, a Ganoid fish represented at the present day in our waters by the gar-pike and sturgeon, and those of *Stenacanthus*, a Placoid characterized by its peculiar dorsal spine and supposed to have been allied to the sharks of the present day. Another remarkable and gigantic fish described by Dr. Leidy as living in the seas of these remote times was *Edestus vorax*, the teeth of which, resembling those of *Carcharodon*, are nearly two inches long. These were

afterwards regarded as spines, which is also the opinion of Sir Richard Owen. According to the recent researches of Trautschold, however, the parts in question in *Edestus* are really teeth as Dr. Leidy first supposed.

Various genera, *Cochliodus*, *Helodus*, *Chomatodus* and *Ctenoptychius* were also described, and their relations to the living *Cestracion Phillippi* or Port Jackson shark of Australia were pointed out. The jaws of this fish, a relic of the most remote ages and of living Placoids, and resembling most the extinct carboniferous fishes just mentioned, are covered with rounded plates much like a cobblestone pavement, instead of the lancet-shaped teeth so characteristic of the sharks of the present day.

About this period the remains of the Walrus discovered upon the coasts of Virginia and New Jersey, were identified as being of the same species as the recent *Trichecus Rosmarus*, which once lived in great numbers in the Gulf of St. Lawrence. These remains were regarded as those of individuals that had been floated upon fields of ice and ultimately deposited upon our southern coasts, or of such as may be supposed to have migrated to the South during the Glacial epoch.

It is well known that the remains of the Peccary have been found in considerable quantities in the states of Illinois, Kentucky, Iowa, Missouri and Virginia. Dr. Leidy was at one time inclined to think that these remains represented a number of genera and species. A more recent study, however, based upon an examination of the recent Peccaries, which the lack of material had previously rendered impossible, convinced him that the remains hitherto described might all be referred to *Dicotyles compressus*. He adds, however, that if the anatomical characteristics offered be considered subgeneric, then the name *Platygonus compressus*, previously employed, would include all the genera and species.

In the year 1865 there was published in the Smithsonian Contributions to Knowledge one of the most important of Dr. Leidy's paleontological works: the memoir entitled "Cretaceous Reptiles of the United States." Most of the fossil remains constituting the subject of this memoir were obtained from the Green Sand or Marl of New Jersey, so extensively excavated for agricultural purposes. They are preserved in the Museum of the Academy. Among them are those of the extinct crocodile *Thoracosaurus*, closely allied anatomically to the Gavial of the Ganges, the skull of which measures

nearly four feet in length and two feet in breadth. Other interesting crocodile-like reptiles described as of the same general character in the work were *Bottosaurus* and *Hyposaurus*. The huge *Cimoliasaurus* and *Discosaurus* measuring sixty feet in length appear to have represented in our waters the *Plesiosaurus* of the English cretaceous seas.

The teeth and some of the bones of the extremities of *Mosasaurus*, an extinct saurian resembling in some respects existing reptiles like the Monitor and Iguana, were also described. In the case of the extremities this was especially important, as few bones that could be identified as such had been discovered among the remains of *Mosasaurus* hitherto described. Indeed Cuvier was so much impressed with the absence of any remains of extremities in the case of the celebrated Mæstricht specimen now preserved in the Jardin des Plantes that at first he was led to doubt whether the animal possessed any limbs. Dr. Leidy also called attention to the remarkable character of the vertebral column of *Mosasaurus*, the co-ossification in the hinder part of the tail and of the chevron bones with the bodies of the vertebræ, a condition previously known only in fishes.

One of the most remarkable reptiles described by Dr. Leidy was *Hadrosaurus Foulkii*, the restoration of which forms a conspicuous object in the Museum of the Academy. It resembles somewhat the *Iguana* and *Cyclura* among existing lizards. This gigantic reptile, the representative during the cretaceous period of North America of the Iguanodon of the Wealden of England, was twenty-eight feet long and, judging from the development of the pelvis and the great difference in the size of the hind as compared with the fore limbs, it probably stood and walked like a bird or a kangaroo, and was provided with a powerful tail like the last named animal. While the femur measured nearly four feet in length and the tibia three feet, the humerus and ulna were only about half those dimensions respectively. *Hadrosaurus* like *Iguanodon* was a vegetable feeder. Its teeth resembled those of the latter but were disposed in rows like a tesselated pavement. One of the most interesting results of the study of the remains of *Hadrosaurus* was the identification of the pubic bone with that described as the clavicle in *Iguanodon*. The determination of the proper relations of this bone was a most important one, leading as it did to the subsequent generalization that the Dinosauria are the ancestors of the birds, the gap between the two groups being filled up by the Struthious birds, such as the ostrich and certain reptile-like birds and bird-like reptiles since

discovered. Among the other reptilian remains discovered in the marl of New Jersey many were recognized as being those of turtles such as *Chelone*, *Emys* and *Trionyx*. *Bothremys Cookii* found near Barnsboro, of especial interest as being the first Chelonian skull discovered in the Green sand formation in the United States, was regarded as closely allied to the great turtle of the Amazon, *Podocnemys expansa*.

During the time intervening between the years 1853 and 1866, the able and indefatigable explorer, Dr. F. V. Hayden, made several visits to Nebraska and Dakota, returning each time with large collections of the remains of the extinct animals of that region, those from the vicinity of the Niobrara river being the first obtained. All these fossils were submitted to Dr. Leidy for determination and, together with those previously described in the "Fauna of Nebraska," etc., already referred to, constituted the subject of his great work, "The Extinct Mammalian Fauna of Dakota and Nebraska," which appeared as Volume VII of the Journal of the Academy, in 1869. In this remarkable work over seventy genera with numerous species of extinct mammalia, many of them new to science, were first described. The Carnivora, Pachydermata, Ruminantia, Proboscidea, Rodentia and Insectivora were especially well represented. Remains of the Equine family were most conspicuous.

The vast number of bones from the pliocene deposits of Dakota recognized by Dr. Leidy as being the remains of horses, led him to infer that the North American Continent, during that period, was emphatically the country of the horse, the different forms being then better represented than in the recent fauna of any part of the world. He was specially interested in the relations of the extinct horses to each other and to those of the present day.

His first communication on this subject was made to the Academy in 1847; his last as recently as May, 1890. He made a collection of the skulls, jaws, teeth, bones of the limbs, etc., of the different breeds and ages of recent horses with the view of comparing them with the corresponding parts of the extinct forms. In speaking of the great difficulties experienced when endeavoring to positively identify certain bones as those of one so-called species of horse as distinguished from another, he observes that if the "bones and teeth of the domestic horse, the mule, the ass, the djiggetai, the hemione, the quagga, the daww, and the zebra, were commingled, they might readily be considered as belonging to varieties of a single

species," and that the "bones and teeth of the three last named species are so nearly alike that, had they been found in a fossil state in Southern Africa instead of the living animals, they would have been unhesitatingly considered as pretaining to a single species." To this circumstance, so thoroughly appreciated by the author, was due his caution in identifying the remains submitted to him as belonging to any particular species of the horse. Indeed the difficulties are so great in determining to what particular species or genus the remains of extinct horses are to be assigned, that it is impossible to say whether or not the several forms first described by Dr. Leidy, are the same as those subsequently described by others.

Without committing himself to any positive theory of the origin of the horse, it may be said that Dr. Leidy, provisionally at least, regarded the genus *Equus* of the Pliocene period as the descendant of the *Merychippus*, or a similar form, which in turn had descended from *Protohippus* and *Hipparion*, the latter having replaced the *Parahippus* of the Miocene, which had been preceded by the *Anchippus* and *Anchitherium* or similar forms of that same period. As to the origin of *Anchitherium*, it will be remembered, as already mentioned, that in his description of that genus he called attention to the fact that this curious animal resembled *Palæotherium* in the form of its teeth, and the horse in the character of its skeleton.

During the five years that elapsed after the publication of the important work on the extinct mammalia of Nebraska and Dakota just referred to, the remains of a great number of extinct vertebrates had been discovered in the neighborhood of Fort Bridger, Wyoming. These fossils, obtained principally by Drs. Carter and Corson, included the remains of fishes and reptiles as well as those of mammals and were, together with others from the Green River and Sweetwater River deposits of Wyoming and the John Day river of Oregon, submitted to Dr. Leidy for determination. The result of his study was given in his "Contributions to the Extinct Vertebrate Fauna of the Western Territories" published in 1873 by the United States Geological Survey. Among these remains he recognized not only those of extinct animals that he had previously described either in the general works we have referred to or in communications made to the Academy, but also those of many new and interesting forms previously unknown to science. Of these *Uintatherium* was one of the most extraordinary. Its name was derived from that of

the Uinta mountains, in the neighborhood of which portions of the skull, jaw and limb bones were found. Its characters were so peculiar and unlike those of any other known animal as to render its ordinal affinities obscure. That great difficulty should have been experienced in determining the nature of *Uintatherium* will not excite surprise when it is remembered that its canine teeth resemble those of the sabre-toothed tiger, its molar teeth those of the tapir, its limbs and feet those of the elephant, while, as subsequently shown, it appears to have been provided with two pairs of horns. This unusual combination of characters is an illustration of how readily a paleontologist may be deceived as to the nature of an extinct animal when fragmentary remains only are in his possession. There can be no doubt that had the skull, jaws, teeth and limbs been found by different paleontologists, as many separate genera would have been described and named. As a matter of fact, when the tusk, the first part of *Uintatherium* discovered, was found by Dr. Corson and submitted to Dr. Leidy's inspection, the latter regarded it, as he himself tells us, as the canine tooth of some large carnivorous animal allied to the sabre-toothed tiger of Brazil, for which he proposed the name *Uintamastix atrox.* The association in the same individual of a tusk-like tooth with two pairs of horns, tapiroid teeth and elephantine limbs would have been deemed impossible by the best comparative osteologist of the day and as violating in every particular the principle of correlation of animal structures as maintained by Cuvier. On the other hand, it is such animals as *Uintatherium* and other similar extinct highly generalized mammalian types that the theory of evolution would lead us to suppose had preceded in time their more specialized descendants of the present day.

This great work was the last of Dr. Leidy's elaborate and important treatises on the paleontology of the Western States and Territories and was regarded by the author, at that time, as his last paleontological work of any kind.

A few years later, however, a collection of fossils from the Phosphate Beds of South Carolina having been placed at the disposal of the author of this memoir, he induced Dr. Leidy to examine the collection with the view of ascertaining if there were among the remains any extinct animals new to science, or of especial interest.

The result of his study of this collection, as well as that of some additional specimens obtained from the same locality and elsewhere, were embodied in his "Description of Vertebrate Re-

mains chiefly from the Phosphate Beds of South Carolina," published in the Journal of the Academy for 1887. Among the remains of extinct animals described in this admirable memoir may be mentioned the teeth of the gigantic sharks, rays and teliosts, the vertebræ, ear-bones and teeth of whales, the bones of the manatee and walrus, the teeth and bones of the elephant, *Megatherium*, horse, tapir, bison, deer, beaver and capybara, many of which were representative of entirely new genera and species.

During the interval elapsing between the publication of the work just referred to, and his death, Dr. Leidy, from time to time as occasion offered, made communications to the Academy on the remains of extinct animals submitted to him for determination. All of these observations are of interest and importance and are marked by the same exactness and accuracy of description, so characteristic of all the work of the great paleontologist.

It will be observed from this necessarily brief resumé of Dr. Leidy's work that he made contributions to the sciences of mineralogy, botany, zoology; general, comparative and human anatomy, and paleontology. Of his numerous scientific communications some were very brief, mere notices; others exhaustive and elaborate treatises. His work, however, whether lengthy or brief was always most exact and accurate. Later investigators in the same fields of research have been able to point out but few errors of interpretation, still fewer of fact. His works are essentially records of facts, often new and of the greatest scientific importance, containing but rarely any generalizations or deductions based upon the same. Possibly no country ever produced a student whose knowledge of nature was at once so accurate and so comprehensive. He was an excellent mineralogist and botanist without claiming to be either, among the highest living authorities on comparative anatomy and zoology, one of the most distinguished helminthologists living, and the equal of any paleontologist at home or abroad.

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